



EXPLORE
MOON to MARS

Surface Habitation Considerations

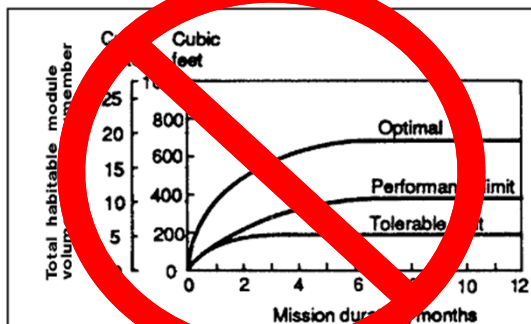
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Surface Habitation

- **Surface Habitation is more than just what is inside the habitat**
 - Entire surface infrastructure is the crew's "neighborhood" for ~300-600 days
- **Crew (and robotic assistants) impacted by**
 - Walking paths between elements (distance, hills, traction, lighting, shadows, etc.)
- **Habitat placement should consider**
 - View outside element windows
 - Direct sunlight on windows (including hatch windows)
- **Look for options for local terrain to assist with radiation shielding (hills, cliffs, etc.)**
 - Includes shielding for habitat/elements and EVA activity near habitat
 - Especially important for long duration missions, sustained ops

Internal Habitable Volume

- **Must provide enough habitable volume (whether modular or monolithic)**
 - Heavy dependency on crew tasks (which themselves may be undefined, especially early in studies)
 - What's good for short duration may not be good for long duration
 - Translation and ingress/egress paths
 - Window and hatch accommodation
 - Stowage, trash, and waste accommodation
 - Crew size and duration are factors, but may not be primary volume drivers
 - Not based on the old NASA-STD-3000 volume vs. duration charts



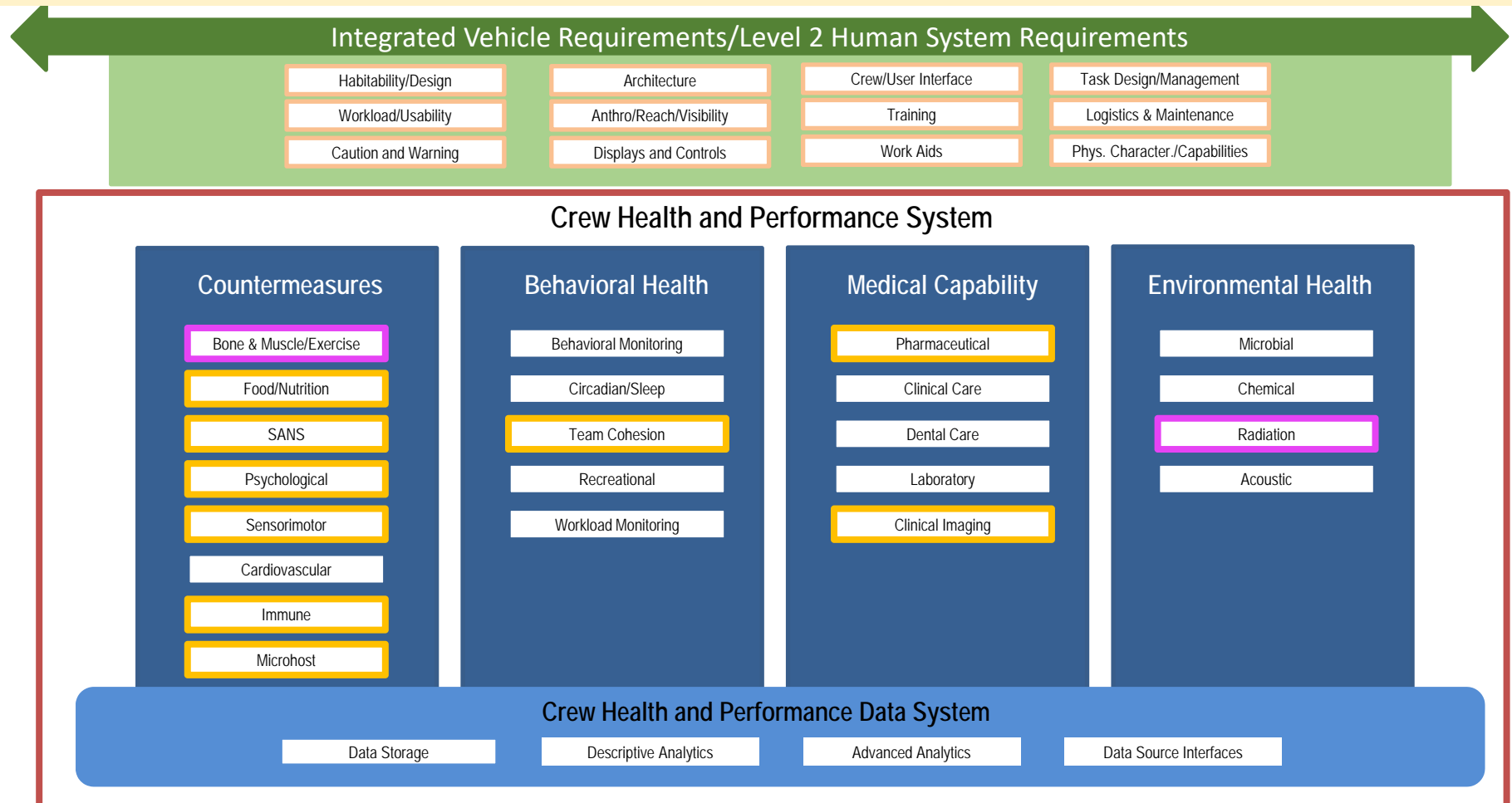
15-May-2019

Mars Integration Group (MIG)

Internal Architecture

- **Identify tasks and performance levels before designing interior**
 - Not just “provide maintenance,” but provide what kinds of maintenance
 - The crew is ALL ALONE...what do they really need to survive and thrive?
- **General design guidelines**
 - Separate potentially conflicting volumes
 - Co-locate sequential functional volumes
 - Only share volumes with caution
 - Separate clean and dirty areas, public and private areas
 - Ensure subsystem access for serviceability
 - Even a “short duration” surface stay is not a short mission
- **Apply virtual and physical human-in-the-loop testing iteratively to down select concepts and refine design**

Crew Health and Performance System (Gateway Example)



Contingency Responsiveness

- **Shuttle and ISS responses to contingency less viable on Mars (or even lunar) surface**
 - Shuttle/ISS crews could/can evacuate and be on the ground in hours or less
 - ISS logistics chain enables on-orbit replacement
 - Mars preparation creates increasing demand to recover from contingencies and continue rather than abort and abandon
 - Less important in a short initial surface mission, but becomes more significant for sustained operations
- **Habitat maintenance capability responsible for all surface assets**
 - Habitat, rovers, robots, lander (when on surface), ISRU, spacesuits, etc.
- **Medical contingencies may happen anywhere**
 - Rover excursions, local EVA, distant EVA, lander, habitat, etc.
 - Do the pressurized rovers need ambulance capability?
 - Is rehabilitation necessary before moving to next phase of mission (e.g. return to orbit)?

Questions?

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